

Seismic Retrofitting for Homeowners

Helping homeowners make informed decisions

Presented by Association of Bay Area Governments



Presenters

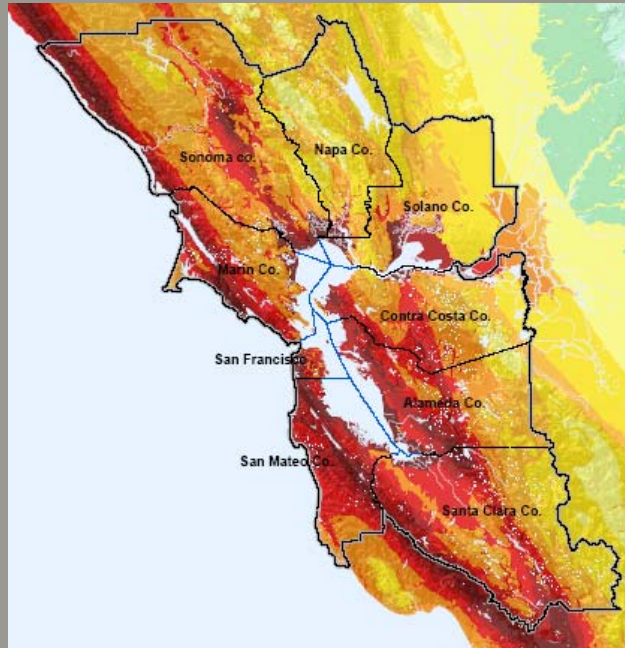
- **Danielle Hutchings, PE, ABAG:** The big picture.
- **Thor Matteson, SE:** Building Codes, When is an engineer necessary?
- **Howard Cook, retrofit contractor:** The principles and practice of seismic retrofitting.

Why are we here today?

- Japan was a wake up call
- We have a lot of work to do
- To learn how to protect our homes and families in an earthquake



Shaking Potential



Alquist-Priolo Earthquake Fault Zones

- Earthquake Fault Zones**
- San Andreas-North Golden Gate
 - San Andreas -- Peninsula
 - San Andreas -- Santa Cruz
 - Rodgers Creek
 - North Hayward
 - South Hayward
 - Northern Calaveras
 - Central Calaveras
 - Sargent
 - Mascama
 - West Napa
 - Concord/Green Valley
 - Greenville
 - Northern San Gregorio

- Major Roads
- Local Roads
- Water



Scale: 1 inch = 3.77 miles

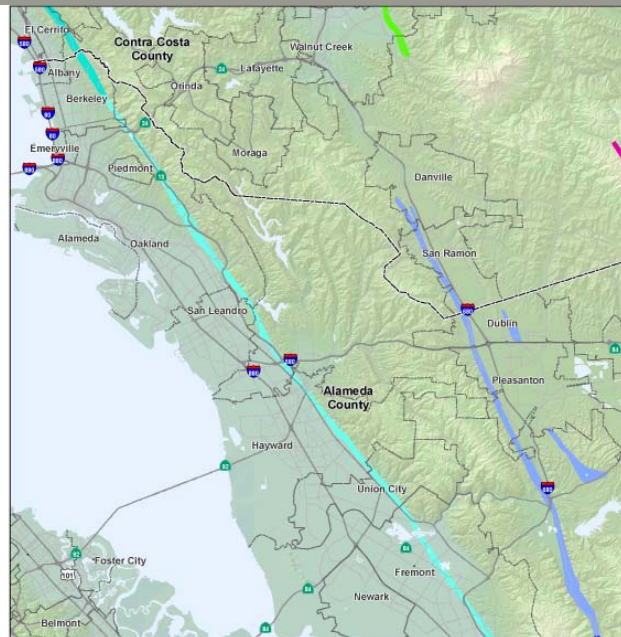
Reproduced with permission, California Geological Survey from CD-ROM 2001-04 (2001), Official Map of Alquist-Priolo Earthquake Fault Zones.

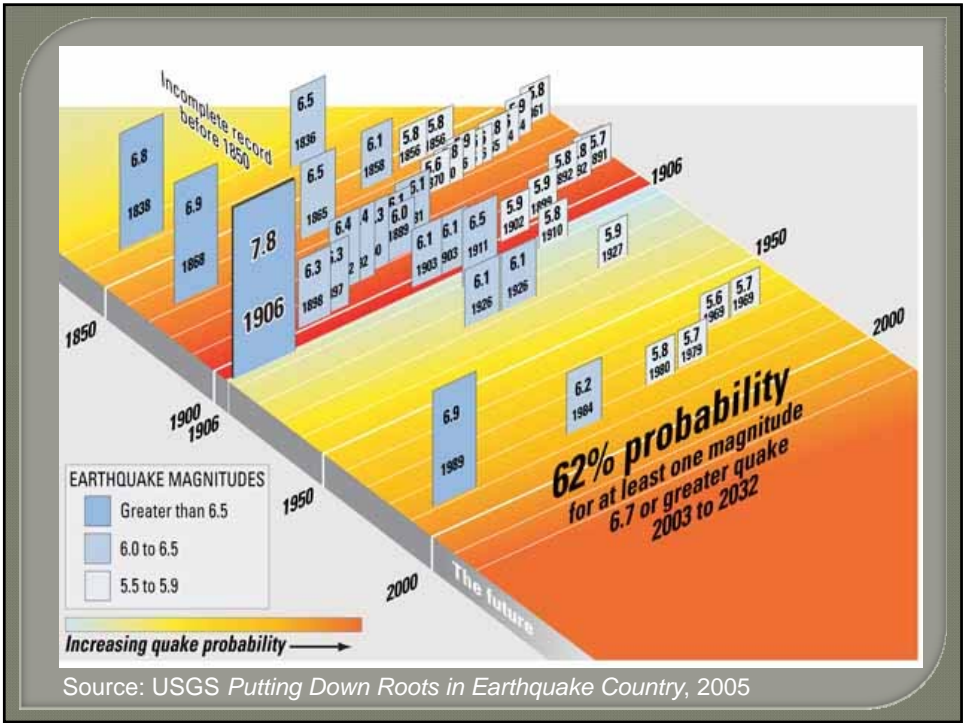
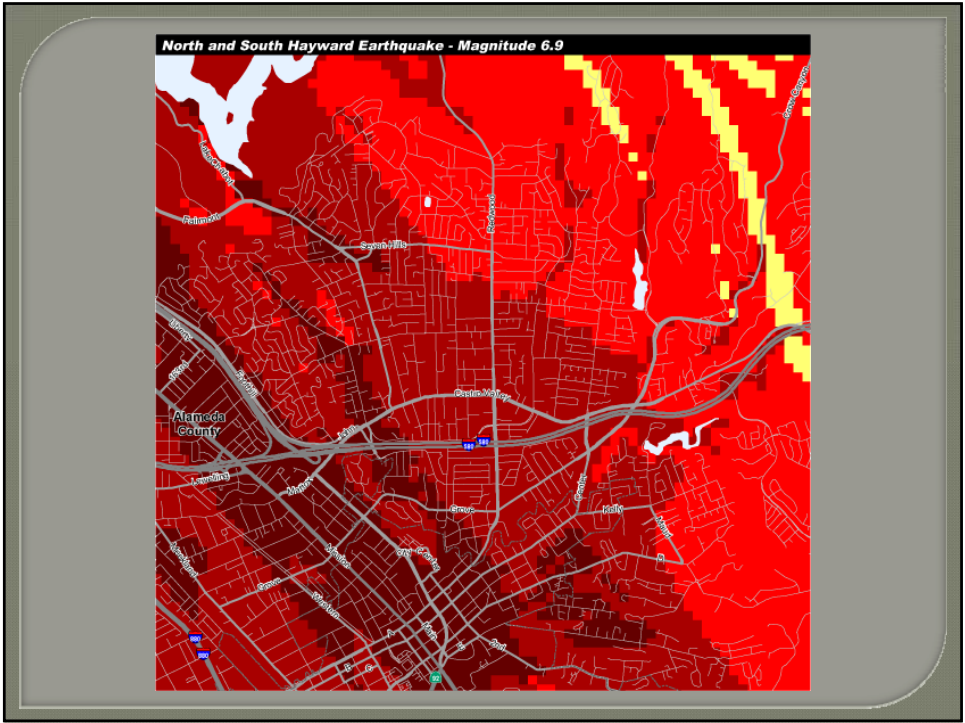
This interactive map was created using digital files of AP UZs as polygons and is considered an electronic derivative of the Official Alquist-Priolo Earthquake Fault Zone map. If there is any doubt or conflict with respect to the location of UZ boundaries, the original clear film overlay compiled by and on file with CGS is the official version of the map. Fault information in these digital files is not sufficient to serve as a substitute for the geological site studies required under Chapter 7.5 of Division 2 of the California Public Resources Code.

For more information visit:
<http://www.consnr.ca.gov/CGS/highmap/>

This map is available at:
<http://quake.alquist.ca.gov/>

ABAG Geographic Information Systems





Why are we concerned?

- \$90 Billion in residential losses
 - Only 5% covered by insurance!
- 356,000 people displaced
- 155,000 uninhabitable dwellings



More cause for concern

- ABAG conducted a survey in 1999 that indicated most retrofits are only partially complete.
- After looking at 35 residential retrofits in 2006, The Contra Costa Times reported that 69% of existing retrofits will not be effective.
- ABAG is working hard to correct this.

Why is this happening?

- ◉ Lack of retrofit codes and educational material
 - State adopted first ever retrofit standards last summer, but only applies to specific conditions
- ◉ Lack of resources for building departments
- ◉ Lack of retrofit contractor licensing

The good news?

Wood-frame homes can perform well in earthquakes if properly constructed or retrofitted

What is ABAG doing about this?

- Working with local governments to find incentives for homeowners
- Developing standard retrofit plan set
- Training contractors on proper retrofit techniques
- Working with local governments to develop a regional hazard mitigation and recovery plans
- Website with resources for residents
<http://quake.abag.ca.gov/residents>

Plan Set A

- Plan Set A
 - Covers about the same scope as State Retrofit standards
 - Developed by
 - ABAG, SEAONC, CALBO, ICC, EERI
- Conditions for Use
 - 1 or 2 Family Residence
 - 2 Stories or less
 - Wood-framed construction
 - Continuous perimeter foundation (except at chimney, porch)
 - Built over crawl space.
 - Non-clay tile roof
- <http://quake.abag.ca.gov/residents/planset/>

Plan Set A

- Most Building Departments will accept without further engineering. Simple instructions
- Provides life safety but may be major damage.
- Gives clear basis to contract for strengthening
- Do it yourself.

**List of ABAG trained retrofit
contractors and engineers online**

[http://quake.abag.ca.gov/residents
/retrofitprof/](http://quake.abag.ca.gov/residents/retrofitprof/)

Non-structural Components

The most common
cause of injuries in
an earthquake!

Chimneys

- We used to think we could brace chimneys!
- Fatalities in the Landers EQ (1992) and near fatality in Napa EQ (2000) changed this.
- Now recommended to remove chimney and replace with wood framing and a metal “zero clearance” flue.

Reinforced Chimney



Braced Chimney Failure



City of L.A. Policy After Northridge

[http://quake.abag.ca.gov/
residents/chimney](http://quake.abag.ca.gov/residents/chimney)



Gas Fires

- Know how to turn off the natural gas.
- Brace water heaters and appliances
- Use long flexible gas lines
- Automatic shutoff valves can help

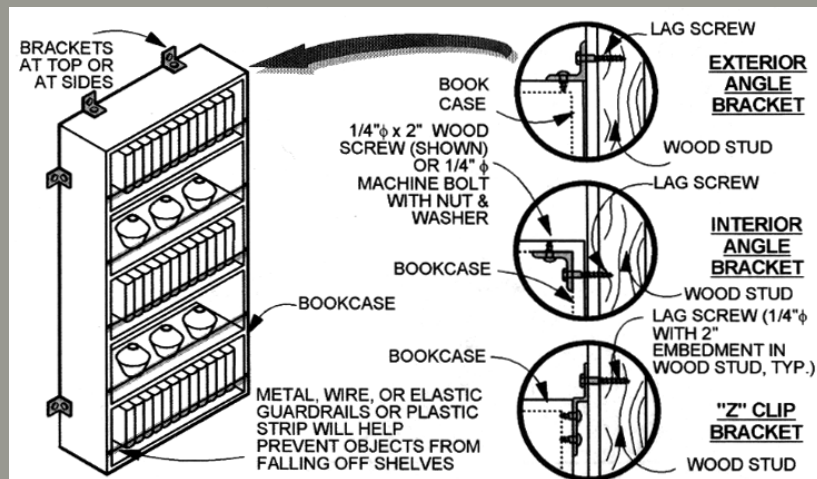


Properly strap water heaters

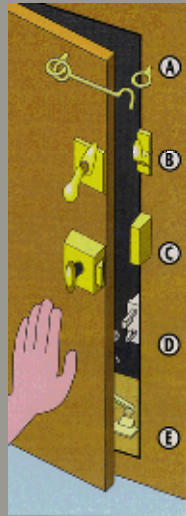
This may be your only water supply!



Anchoring Large Objects



Positive latches keep your dishes in the cabinets



Protect Yourself

- In a big earthquake....
 - Cities and counties will not be able to help everyone - Be Prepared!
 - Help may come very slow - If at all
 - Help and seek help from your neighbors
 - FEMA will not provide adequate assistance to get your life back in order

What else should you do to prepare?

- Plan Ahead:
 - Have supplies in car and home
 - Develop a family response plan and meeting location
 - Form or join a neighborhood group
 - Establish an out of state phone number which everyone will call
- During shaking:
 - Duck, cover, and hold if you can
 - Get away from potential falling objects
 - Don't run outside
 - Crawl if you need to
- Once shaking stops:
 - Go outside and stay there
 - After some time, go back **if safe** and put everything on floor

Thor Matteson

Structural engineer & author of
*Wood-framed Shear Wall Construction—
an Illustrated Guide*

Current Codes and Standards

- ◉ Voluntary
 - Plan Set A
 - Custom “un-engineered”
 - Custom engineered
- ◉ Mandatory
 - New construction
 - Ongoing for old brick buildings
 - Future—for multi-family

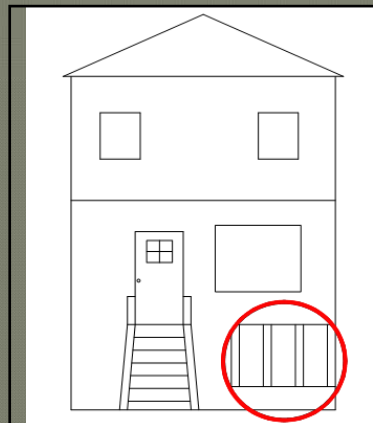
The Goal of retrofit

- ◉ Keep the house on its foundation and keep it habitable. Strengthening Limited to attaching the floor to the foundation.
- ◉ Reduce property damage and the number of uninhabitable homes after an earthquake.
- ◉ Your house may still suffer significant damage in a substantial earthquake.



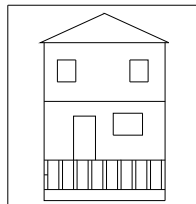
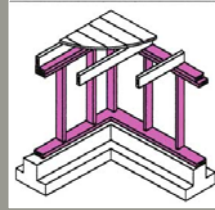
Two similar Santa Cruz Victorian style homes were built 110 years ago. One was retrofitted before the 1989 Loma Prieta earthquake—it needed \$5,000 in repairs. The other house cost \$250,000 to repair.

Cripple Wall Retrofit

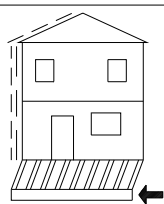




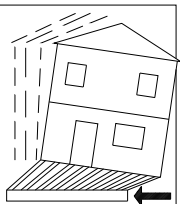
What happens to cripple walls



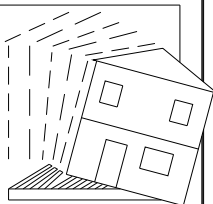
HOUSE IS SUPPORTED
ON CRIPPLE WALLS



EARTHQUAKE MOVES
THE FOUNDATION



HOUSE ROCKS ON
THE CRIPPLE WALL



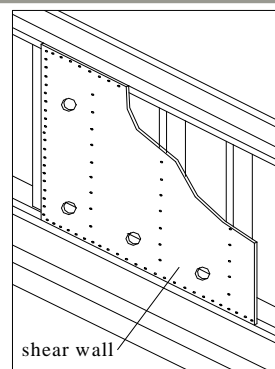
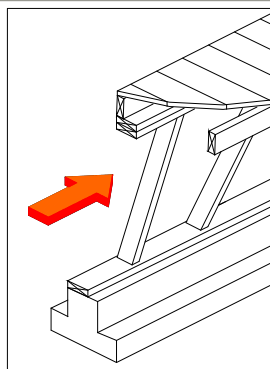
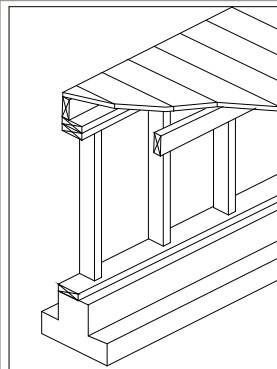
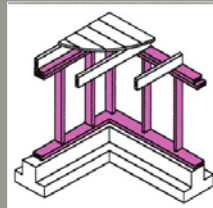
HOUSE FALLS WHEN
CRIPPLE WALL COLLAPSES

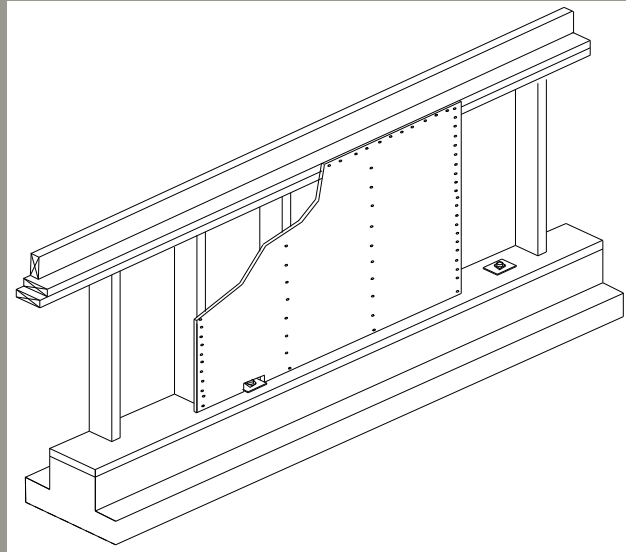






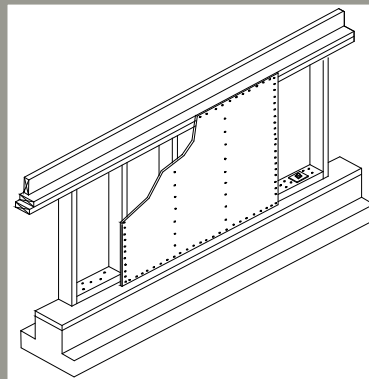
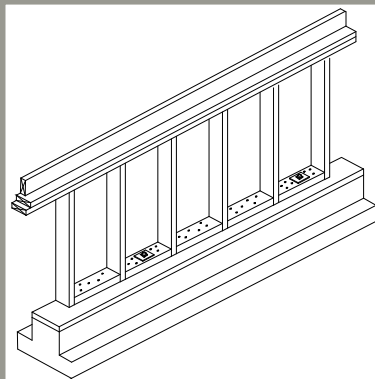
Cripple wall collapse prevented by plywood





PROBLEM: Mudsill wider than studs

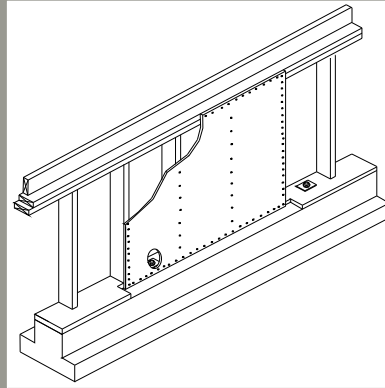
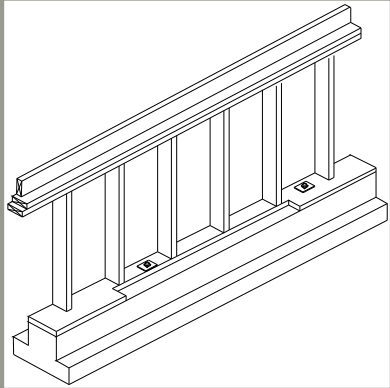
Nailed Block Method



Guy nailing blocks

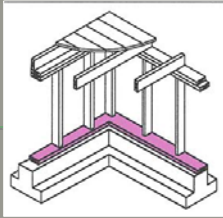


The Flush Cut Method

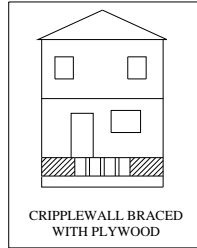


Original mudsill—
Ancient Redwood

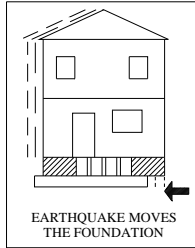
“Tree-farm” wood—
Splits easily



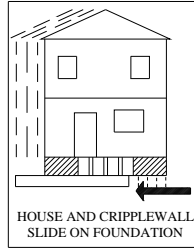
Bolting the braced cripple walls to the foundation



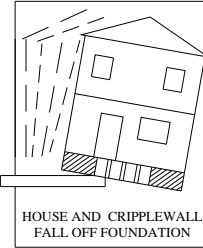
CRIPPLEWALL BRACED
WITH PLYWOOD



EARTHQUAKE MOVES
THE FOUNDATION



HOUSE AND CRIPPLEWALL
SLIDE ON FOUNDATION

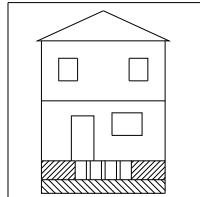
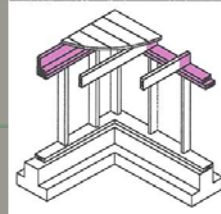


HOUSE AND CRIPPLEWALL
FALL OFF FOUNDATION

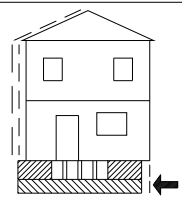
3 kinds of bolts



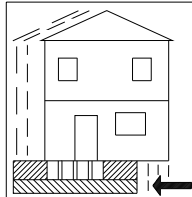
Attaching the floor of the house to the braced cripple walls



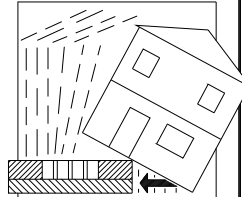
CRIPPLEWALL BRACED
WITH PLYWOOD AND
FOUNDATION BOLTED



EARTHQUAKE MOVES
BRACED CRIPPLEWALL
& BOLTED FOUNDATION

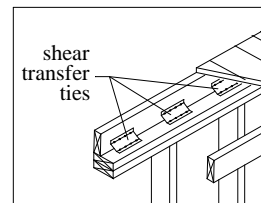
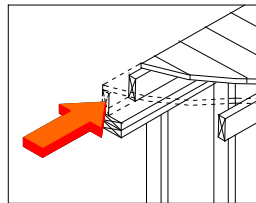
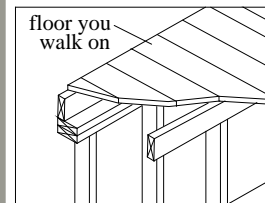
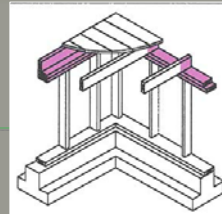


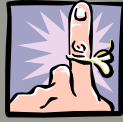
FLOOR OF HOUSE
SLIDES ON TOP
OF CRIPPLEWALL



HOUSE FALLS OFF
BRACED CRIPPLEWALL
& BOLTED FOUNDATION

Movement prevented by shear transfer ties





Remember all three

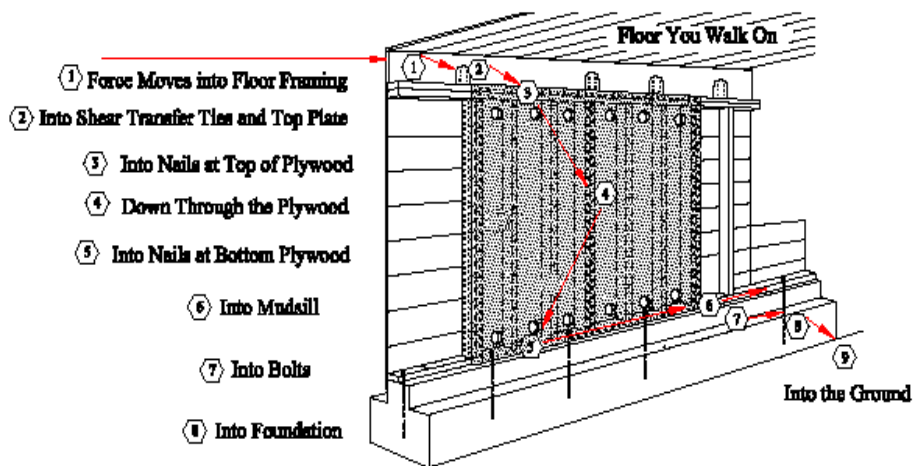
1. BRACE cripple walls with plywood.
2. BOLT cripple walls to the foundation.
3. CONNECT the floor of the house to the braced cripple walls

Can a retrofit be too strong?

- No—but they can be Too Expensive
- Much easier to make new houses strong
- Under-floor retrofit gives most protection for least cost
- How much damage can you tolerate?
- Compare to new construction
- Want a system where all parts work together
- Same strength for all parts of system

Questions to ask your contractor

- Have they completed ABAG training?
- What grade of plywood do they use?
- What type of plywood nails?
- What sort of hardware and fasteners?
- Do they design the retrofit themselves?
- How do they determine the EQ forces?
- Do they use special care not to split wood members?
- You should check the installation before the plywood goes up



Load Path of Earthquake Forces

No Cripple Wall





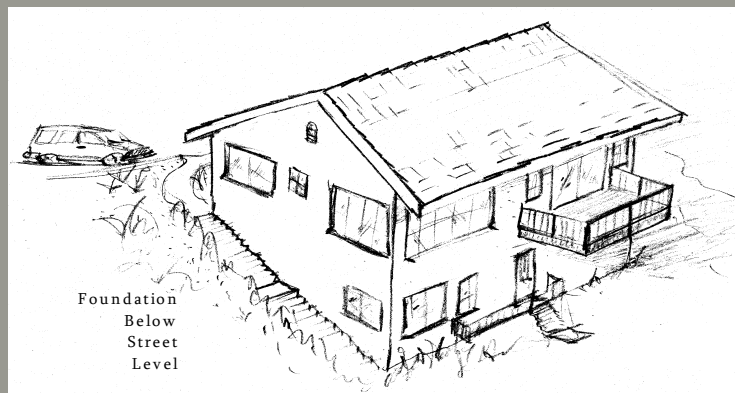
Attached Garages ("Soft Story")







Hillside Homes



Typical Hillside Home
with hillside hazards

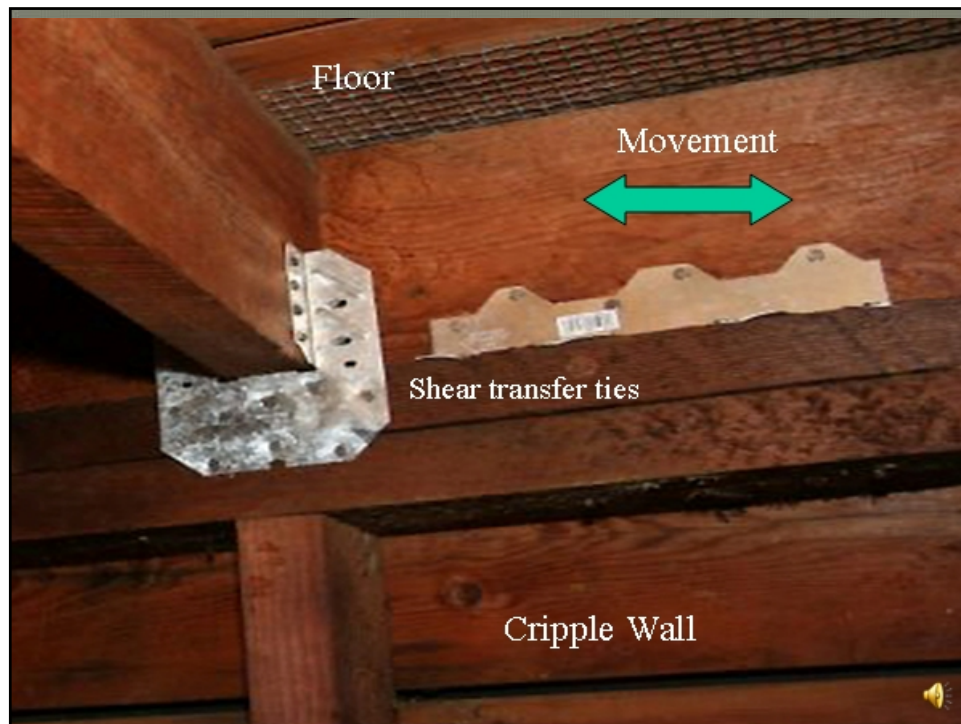


Howard Cook

Retrofit contractor

Howard's
Dog and Pony
Show





Bad Retrofit Methods

Some retrofit methods do not work well, or they are VERY expensive





Steel Angle shown is about $\frac{1}{4}$ as strong as a single mudsill bolt.

Home-made connections like this have never been tested





SIMPSON ITS 12 @
5'-4" O.C. STAGGER
EACH SIDE OF GIRDER

1/2" A307 MATERIAL THREADED
ROD EPOXY IN HOLE -
SEE NOTE SHEET 1 USE WASHER
AND NUT - TORQUE SNUG TIGHT

SIMPSON 128T EACH
SIDE AT EACH POST
10d END NAILS

2-
SIMPSON A24 EACH
SIDE AT EACH POST

128T	14	12	8	2	12-16d	3	1/2
1212T	14	12	12	2	12-16d	3	1/2

1. Connectors are not load-rated.

Connecting floor beams to posts is
usually not needed.



Additional Resources

- ABAG website quake.abag.ca.gov
 - Do-it yourself class information
 - List of contractors and engineers
 - Standard retrofit plan set
 - How to secure your home's contents
 - How to make an earthquake plan
- California Seismic Safety Commission
 - *Homeowner's Guide to Seismic Safety*
- US Geological Survey
 - *Putting Down Roots in Earthquake Country*